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# **Characteristics of Schools for the Deaf that offer Comprehensive Science Programs: A Descriptive Profile**

Submitted to the Faculty of the  
Masters of Science Program in Secondary Education  
of Students who are Deaf or Hard of Hearing

National Technical Institute for the Deaf  
ROCHESTER INSTITUTE OF TECHNOLOGY

Master's Thesis

By

Patrick D. Freivald

In Partial Fulfillment of the Requirements  
for the Degree of Master of Science

Rochester, New York

May 1, 2000

Approved: \_\_\_\_\_

(Project Advisor)

\_\_\_\_\_  
(Program Director)

## **Abstract**

Studies documenting the state of science education for deaf students are two decades old. However, these studies give insight into many of the reasons that science education is lacking in so many areas. The present study examined the differences in characteristics between schools for the deaf that offer higher level sciences such as chemistry and physics and schools for the deaf that do not. To this end, a survey was distributed to a sample of schools for the deaf in New York and Pennsylvania in an attempt to identify these differences. The primary finding of this study is that the responding schools that offer comprehensive science programs that include Chemistry and Physics differ in one major aspect from schools that do not: they cooperate with another educational institution to fulfill these needs of their student body. A secondary finding was that newer, more rigorous standards might negatively influence a school for the deaf's ability to offer higher level sciences to its students.

## **I. Introduction**

Ever since I decided to enter the field of science education for deaf students, it has been made clear to me that the field has many needs. Research exists showing how, across the board, graduates from residential and day schools are inadequately prepared either for college or for living in a highly technological society. For either, a comprehensive science program is necessary. Some research pinpoints possible reasons that students are unsuccessfully prepared in these areas, but no studies compare schools with comprehensive science programs to those without such programs.

### **Statement of the Problem**

One indication of a comprehensive program would be that it offers higher level science classes to students. That is, students have the opportunity to take chemistry and physics should they choose to do so. However, there is some indication that in many schools even the brightest of students do not have the opportunity of pursuing chemistry or physics in the classroom. Operating under the assumption that this is true, it would be reasonable to attempt to determine why these classes are offered at some schools but not at others. To do this, a survey was sent to administrators and science teachers of deaf students.

## **II. Literature Review**

Deaf education in the area of math and science is in serious trouble. Research indicates that teachers of deaf students are inadequately prepared to teach math or science, and that certification in mathematics and science is the exception rather than the rule. Furthermore, few teachers have opportunities to receive professional training in their fields. National standards in mathematics are inadequately implemented in schools for the deaf. Compounding these problems is the fact that most math and science classrooms lack basic equipment (or even space to store that equipment), and funding is unavailable to acquire more. Finally, it appears that math and science achievement is directly tied to English skill. This means that educators will not be able to salvage math and science education without focusing on English education as well. All of this adds up to a challenging picture of deaf education in the areas of math and science. The many good teachers in the field with the will to improve their programs and classes may very well not have the capital, training, or space to do so.

Are teachers of the deaf effective in teaching math and science to their students? The answer to this question is directly tied to the training of each teacher. A study performed by Lang, McKee, and Conner (1993) showed that teachers, administrators, and students agreed on the primary characteristic that makes a teacher effective: knowledge in the content area being taught. This means that, in order for a teacher to be effective, they must have the appropriate training in the content area that they teach. Research has shown, however, that for the most part this is not the case.



According to Corbett and Jensema's descriptive profiles of deaf educators from the early eighties, only 3.4% of teachers of deaf students had undergraduate majors in the sciences, with only 1.1% holding certification in at least one science. However, 41.2% of teachers of deaf students teach at least one science class (Corbett and Jensema, 1981). Of science educators of the deaf, 73.6% had no degree in science education, and almost half of these had not taken even one college science course (Lang and Propp, 1982). Only 15.2% of science teachers of the deaf were specifically certified in science. Since each of the major sciences (earth science, biology, chemistry, and physics) requires its own certification in most states, this means that the number of teachers of the deaf teaching science classes in which they are actually qualified to teach is next to none. Of the 196 teachers from both residential and mainstream programs who responded to a 1996 survey as part of the National Science Foundation grant "Access to English and Science Outreach Project," 21 percent has bachelor's degrees in a field of science, 7 percent have master's degrees in science, and fewer than 36 percent have certification in science teaching. Thus, more recent data indicates the problem of teacher preparation continues to be serious.

Recent statistics for math are not encouraging (Pagliaro, 1997). Only 51% of math teachers of the deaf have a college major or minor in a mathematics-related field, with almost half of these (24% of the total number of math teachers) having only a minor in math. By comparison, 81% of regular education math teachers have a major or minor in math. Math teachers of the deaf at the high school level reported taking an average of 7.5 math-related courses, barely half of the number recommended by the National Council of Teachers of Mathematics (NCTM) Standards.

Worse yet, schools do little to support career development and training for math teachers of the deaf (Pagliaro, 1997). Sixty-nine percent of schools for the deaf have no teachers who are members of professional mathematics organizations, while 43% offer no in-service training sessions for math teachers. Seventy-five percent of schools for the deaf do not offer training incentives such as release time, partial reimbursement of expenses, or travel/per diem pay. In fact, schools only have an average of three professional mathematics publications available to teachers. Less than 40% had a copy of the NCTM Standards, and only 7% had a copy of the National Action Plan for Mathematics Education Reform or the Deaf (NAPMERD) report, which discusses how the Standards relate to deaf education in mathematics. With these problems persistent in mathematics, there is no reason to assume the similar problems in the sciences have been resolved.

Mathematics teachers of the deaf were behind the times in 1977 (Johnson, 1977). Approximately 50% of the time spent on math instruction was drill and practice, with individual instruction occurring less than 5% of the time and discovery techniques (hands-on learning, etc.) being used only 18% of the time. Furthermore, no evidence can be found that these techniques have been specially modified for use with a deaf student body. Unfortunately, things have not improved much in 21 years.

According to Pagliaro's study of math teachers and compliance with the NCTM Standards (which advocate discovery techniques and reduction of drill and practice teaching in math), most teachers and administrators are either unaware or only peripherally aware of the Standards (Pagliaro, 1998), and very few teachers use new

methods frequently. Eighty-five percent of math teachers of the deaf use calculators or computers, but few take advantage of their potential for open-ended exploration (discovery techniques). Almost 75% of math teachers of the deaf used textbooks as a curriculum guide, whereas the Standards say that textbooks should be a tool for teaching and not a curriculum in and of themselves. Finally, assessment was used formatively only 49% of the time, whereas the Standards advocate formative evaluation as the primary use of assessment. Thus, it is clear that, 21 years after the identification of problem areas, little has improved in methods of mathematics instruction.

Curricula in math and science was also weak twenty years ago. Only 26.8% of science teachers of the deaf felt that their students were being adequately prepared "for postsecondary training in various fields of sciences and technology" (Lang & Propp, 1982), and 38.7% reported that students spend three hours or less on science instruction each week. Only 12.2% identified their curriculum as process-oriented. In math, only 50% of schools reported having any formally established curriculum at all (Johnson, 1997). Eighty percent used textbook-based curricula, and only 56% of high schools spent four or more hours a week on math instruction. Furthermore, curricula emphasized math skills needed for day-to-day living, providing little for students seeking careers in math or science.

It is difficult to teach even the best curriculum without proper facilities and equipment. Only 29.3% of science teachers of the deaf report satisfactory or better laboratory resources, with 9.9% describing their setting as a modern, up-to-date teaching laboratory (Lang and Propp, 1982). Only 32.5% reported having enough storage and display space for the equipment that they did have. Only 43.1% reporting satisfactory audiovisual materials, while 71.5% said they had content needs for which no captioned movie titles were available. 81.8% reported their budget for materials to be unsatisfactory. How much these conditions have changed since the Lang and Propp (1982) study is not known.

As for math, 82% reported having no math lab facilities, and 27% who did have math lab facilities didn't use them because of a "lack of available materials" (Johnson, 1977). Also, Johnson's data suggested that the huge variety of books used in math instruction are not appropriate for deaf learners. Combined, this means that science and math teachers of the deaf did not have the resources necessary to get the job done.

A final complication in math and science education for the deaf is the relationship between math/science, language, and background knowledge. A lot of information is gained from reading math or science texts, interpreting word problems, and similar language-intensive tasks. Thus, language (and especially reading) ability is very important for the acquisition of background knowledge in a science or mathematics course. However, the ability to find logical inconsistencies in text is related to the amount of background knowledge that a student has on that particular subject (Thornton, 1989). In fact, background knowledge seems to be more important than hearing loss in the ability to determine how logical a text is. Worse yet, science is an area where logical consistency in reading and writing is extremely important, and is also an area where deaf students are already lacking a lot of background knowledge. This means that deaf students need to gain background knowledge in math and science in order to understand written texts so that they can gain background knowledge in the subject - a tough cycle



that needs to be broken so that true learning can occur. These factors combine to make science-related English literacy even more difficult for Deaf students than 'regular' English literacy.

Another science-related language problem lies with the technical vocabulary involved in science and mathematics, and may be as much of a problem for teachers as it is for students. A study of public school, private school, and college teachers indicated a deficiency in teachers' abilities to properly classify statements into three terms critical to scientific processes: observation, inference, and hypothesis. While both pre-service and current secondary teachers scored in the 90% range for observation, scores for hypothesis and inference were very low. In fact, the mean score for all three terms was 72% for pre-service and 69% for current secondary teachers (Folette & Smith, 1992). If hearing teachers of science with English fluency score only (approximately) 70% in identifying the three words that are most crucial to any hands-on experimentation, they cannot possibly teach deaf students to do any better.

English usage does not just relate to science, however. Hillegeist and Epstein showed that the more abstract English used on an algebra problem, the more difficult it is for deaf students. Though the level of math is more important than the English level in determining difficulty, there is some evidence to indicate that English had more of an influence as the math becomes more abstract (Hillegeist & Epstein, 1988). This means that English ability cannot be separated from math and science proficiency, and creates an even greater challenge for math and science teachers of the deaf.

Some programs have developed methods for incorporating English into science instruction that have shown some success. At the Lexington School for the Deaf, educators set up a Local Area Network (LAN) for science classroom communication (Bell, Reich, & Moeller, 1991). High levels of use by students resulted in decreased morphological errors, improved ESL-evaluated English scores on every measure except vocabulary, slightly increased local connections in writing, and dramatically decreased connection errors in writing. With further research and in-class experimentation, new teaching methods that foster learning of science, math, and English together can be developed and implemented.

Overall, the picture for math and science education for the deaf is bleak. Problems that have plagued the system for over twenty years show no sign of abating, largely because of financial reasons. Without capital, schools will not be able to afford training programs or better equipment, steps that need to be taken to comply with national standards cannot be taken, and special programs to integrate English use into science and math classrooms cannot be developed. Perhaps outside sources of funding will be made available to take these steps. Perhaps some of these steps will be taken without the extra funding. Either way, something must be done to help teachers of the deaf in science and mathematics do their job and educate deaf students to the best of their abilities.

***Note:** This literature review examines both math and science, because there is a logical connection between the two. While science can be taught on a basic level without math, skill in mathematics is needed in order to fully comprehend and use scientific*

*concepts. Furthermore, no information was available on the difficulties in implementing comprehensive science programs. The problems presented for science in general will most certainly effect the inclusion of chemistry and physics into a science program, but obstacles specific to higher-level sciences have yet to be identified.*

### **III. Design**

#### **Goal**

The focus of this research is to compare characteristics common to schools that offer comprehensive science programs that include upper level sciences to schools that do not. Through analysis of the results, it may be possible to formulate steps that need to be taken to offer chemistry and physics to all deaf high school students.

#### **Method**

A survey approach to data collection is most appropriate for this study because it will allow for a reasonable sampling of schools. It is hoped that this study will provide a foundation for future research.

A questionnaire was developed using the available literature on the subject to identify potential characteristics of the schools and their science programs. Questions cover school size, budget, space available, teacher characteristics, and student characteristics, as well as what science courses are offered and why any of the core courses (Earth Science, Biology, Chemistry, and Physics) are not offered. These questionnaires were sent to teacher of the deaf in sciences and to administrators, either heads of science departments or principals, in order to gather both the teachers and the administrators perspectives.

As a pilot study, only schools in New York State and Pennsylvania were targeted.



## **IV. Results**

### General Characteristics:

Of the fifteen schools surveyed, four (27%) responded. The schools had an average of nineteen students in the high school, with the smallest school having eight and the largest thirty. Annual funds budgeted for science were not available in two of the cases, but in the two that responded the budget was under \$1000 and less than \$100 per student. Neither funding nor school size seemed to have an impact on the availability of upper-level science courses for the students.

### Summary of Results:

<b><u>Characteristic</u></b>	<b><u>School A</u></b>	<b><u>School B</u></b>	<b><u>School C</u></b>	<b><u>School D</u></b>
<u>Number of Students</u>	30	8	NR*	19
<u>Number of Science Teachers</u>	1	1	2	1
<u>Annual Science Budget</u>	\$200	\$700	NR*	NR*

\* NR means no response was given on the survey.

### Courses Offered:

Of the schools that responded, A, C, and D (75% of the respondents) offer Earth Science and Biology, C and D (50%) offer Chemistry, and D (25%) offers physics. School B offers none of the above but instead offers a general science course as well as mandatory vocational training for all students. A and C, instead of offering Chemistry or Physics the senior year, offer alternative science courses for the senior year: environmental science in school C and 'senior science' in school A. School D, the one school that offered all four core courses also offered Sports Medicine, Forensic Biology, Nutrition, and Astronomy to any interested students.

These results are summed up below:

<b><u>Course</u></b>	<b><u>School A</u></b>	<b><u>School B</u></b>	<b><u>School C</u></b>	<b><u>School D</u></b>
<u>Earth Science</u>	Y	N	Y	Y
<u>Biology</u>	Y	N	Y	Y
<u>Chemistry</u>	N	N	N	Y
<u>Physics</u>	N	N	N	Y
<u>Other</u>	Y*	Y**	Y***	Y*****

- \* Senior Science
- \*\* General Science and Vocational Training
- \*\*\* Environmental Science
- \*\*\*\* Sports Medicine, Forensic Biology, Nutrition, Astronomy

#### Reasons Chemistry and Physics were Not Offered:

Two schools identified time restrictions as the reason higher-level science courses are not offered. In School C, Earth Science and Biology are both given 1.5 years, while in school A Earth Science is given 2 years and biology one year. This leaves only one year to teach another science course, so a general science or environmental science course is taught instead of trying to fit Chemistry or Physics into a one year program. School A also stated that new books and materials would be needed if Chemistry were to be offered, though they have the materials and books to teach physics should a qualified and interested student body appear. This school also alluded to limited time as a factor for not offering these courses, though how time fits into the equation was not clear.

Three out of four of the schools (A, B, and C) shared one reason why they are unable to offer all of the science courses - more rigorous educational standards. The standards in New York require Regents Biology and one of the other three core courses. As Earth Science is deemed to be more accomplishable than either Chemistry or Physics, two of the New York schools in this study choose to focus on Earth Science and Biology in order to assure that their students fulfill the requirements and graduate. The other school that mentioned standards merely stated that Chemistry and Physics are not required, and so they focus their additional resources on vocational training.

#### The Feasibility of Offering Chemistry and Physics to Interested and Qualified Students:

School B stated that it could not offer Chemistry and Physics to its students, as they are already enrolled in vocational training. School A claimed that while Physics is possible, new materials and books would be needed to offer Chemistry. Schools C and D both already offer Chemistry, and D also offers Physics as well as many other sciences (Forensic Biology, Sports Medicine, Nutrition, and Astronomy). Both of these schools share an important trait that is not shared with the schools that do not or cannot offer upper-level sciences - cooperation with another institution.

School C is planning on offering a three week, distance learning Physics course next year, in cooperation with the National Technical Institute for the Deaf (NTID). If this program succeeds, they may consider offering one semester of Chemistry and one semester of Physics to qualified students in their senior year. This experimental program may be the springboard through which physics is brought back into their school.

School D offers the most comprehensive program of any of the respondents, even though they admit to having 'no space or equipment' for science instruction. They are able to do this because they are in cooperation with a local, public high school. Any qualified and interested deaf student can take classes at the nearby public school, with the full support of interpreters, note takers, and tutoring from the science teacher of the deaf at their day school. Thus, all science courses offered by the local high school are available to those students willing to venture out into the mainstream to take them.

The new standards cause a problem even here, though. Because of the strict laboratory requirements of Regents-level Earth Science and Biology, this school is no

longer able to offer all-deaf classes in these subjects due to a lack of space and equipment. Instead, these courses will be taken through the local high school with the services mentioned above available to all students who require them. With students being required to take the lower-level sciences in the mainstream, this might encourage more to take higher level sciences in the same cooperative mainstreaming environment. The true impact has yet to be seen.



## **V. Conclusion**

The schools in this study that offer comprehensive science programs that include Chemistry and Physics differ in one major aspect from schools that do not: they cooperate with another educational institution to fulfill these needs of their student body. This was true of the only two schools to offer Chemistry or Physics, and it did not seem dependent upon school size or science budget. School C will offer Physics through a distance-learning program set up through a local college. School D offers many science courses through cooperation with a nearby public high school. There are many reasons this may be the case.

Perhaps the small size (and thus limited capital, equipment, and space) of schools for the deaf prevent them from offering these courses on their own. Perhaps there are only two or three students willing and/or able to take these courses, and thus their money, space, and equipment is best spent elsewhere. It could also be that there are no teachers qualified and certified to teach these courses at a level that will do the students a lot of good. In any of these cases, it makes sense that the schools turn to their neighboring educational programs to cooperate in bringing these courses to their students.

Of course, the scope of this study was limited, and making broad generalizations from this data would be inappropriate. However, the findings of this study may be helpful to future researchers. Some questions that can now be explored include: How many schools for the deaf cooperate with nearby high schools and colleges to provide courses in Chemistry and Physics? How successful are these cooperative ventures? Can similar partnerships be formed in schools that do not have them, and if so, how? All of these questions might lead to comprehensive science programs for deaf students around the country.

Finally, another question arises from the data: to what extent does the drive for higher standards limit the educational opportunities of deaf students? Three out of four respondents (schools A, B, and C) indicated mandated standards as at least a part of the reason that they do not offer either of the higher level sciences. Furthermore, school D is transferring all of its science to the mainstream in order to comply with New York State standards. This question needs to be answered before the full impact of new, higher standards can be revealed.

All of these questions could be answered by further research by building upon the results of this study. Though small in scope, this study generates two important questions that bear further investigation: what are the effects of higher standards mandated by the states, and how does using cooperative programs effect the ability of schools for the deaf to offer comprehensive programs to their students? Answering these questions may be the key that opens the door to Chemistry and Physics for all deaf high school students.

## **Appendix A: The Survey**

**School Name:** \_\_\_\_\_

**Number of Students in High School:** \_\_\_\_\_

**Number of Science teachers in High School:** \_\_\_\_\_

**Annual Science Budget, excluding salaries (if known):** \_\_\_\_\_

**The following courses are offered at my school (check all that apply):**

- ☐ Earth Science
- ☐ Biology
- ☐ Chemistry
- ☐ Physics
- ☐ Other: \_\_\_\_\_

**For any of the above that are not checked, why are these courses not offered:**

### **Earth Science**

- ☐ Not enough teachers
- ☐ No teachers qualified or certified to teach this course
- ☐ Insufficient materials/budget
- ☐ Insufficient space for course work or storage
- ☐ Students not prepared well enough
  - ☐ In math skill
  - ☐ In English skill
  - ☐ In general academic skills
- ☐ Insufficient interest from student body
- ☐ Other: \_\_\_\_\_

### **Biology**

- ☐ Not enough teachers
- ☐ No teachers qualified or certified to teach this course
- ☐ Insufficient materials/budget
- ☐ Insufficient space for course work or storage
- ☐ Students not prepared well enough
  - ☐ In math skill
  - ☐ In English skill
  - ☐ In general academic skills
- ☐ Insufficient interest from student body
- ☐ Other: \_\_\_\_\_

### **Chemistry**

- ☐ Not enough teachers
- ☐ No teachers qualified or certified to teach this course
- ☐ Insufficient materials/budget
- ☐ Insufficient space for course work or storage
- ☐ Students not prepared well enough
  - ☐ In math skill
  - ☐ In English skill
  - ☐ In general academic skills
- ☐ Insufficient interest from student body
- ☐ Other: \_\_\_\_\_

### **Physics**

- ☐ Not enough teachers
- ☐ No teachers qualified or certified to teach this course
- ☐ Insufficient materials/budget
- ☐ Insufficient space for course work or storage
- ☐ Students not prepared well enough
  - ☐ In math skill
  - ☐ In English skill
  - ☐ In general academic skills
- ☐ Insufficient interest from student body
- ☐ Other: \_\_\_\_\_

**Are there any other requisites needed in order for your school to be able to offer these science courses? Please list any/all things you feel are necessary that are not listed above.**

Science classes in general:

Earth Science:

Biology:

Chemistry:

Physics:

**If your school had a small group (approximately 2 to 5 students) that were qualified, how could your school meet their needs in chemistry or physics?**

**Are there any further comments you would like to make about how your school chose which courses to include in your high school science curricula, and which to exclude?**

**I wish to receive the results from this study. (Circle one)**

Yes

No



## **Appendix B: Cover letter**

Patrick D. Freivald  
National Technical Institute for the Deaf  
Masters in Secondary Education Program  
1 Lomb Memorial Drive  
Rochester, NY 14620

Dear Science Program Administrator:

My name is Patrick Freivald, and I am a graduate student at the National Technical Institute for the Deaf (NTID). Towards the completion of my master's degree in education of the deaf, I am sending out this survey as part of my master's thesis. The goal of this survey is to identify why different schools and programs for the deaf choose to offer different science courses to their students. A secondary goal is to identify the different resources needed to offer science courses at schools that currently do not offer them.

The results of this survey will not be published, but results will be sent to any participants who desire them. Just circle the 'yes' at the bottom of the survey and the results will be sent to you.

Please take the time to fill out this survey – it should only take a few minutes. For your convenience, a postage-paid, addressed return envelope has been included. Please return this survey by U.S. mail by March 31<sup>st</sup>. Your help in this project is greatly appreciated.

Thank You,

Masters in Deaf Education Student  
National Technical Institute for the Deaf

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